

## ABSTRACT

Ultrafast square-law detectors amplify electric currents and electromagnetic waves with frequencies on the order of 100 GHz or more. The detectors use injection of spin-polarized electrons from a magnetic film or region into another magnetic film or region through a thin semiconductor control region. A signal current flowing through a conductive nanowire induces a magnetic field causing precession of electron spin injected inside the semiconductor layer and thereby changing the conductivity of the detector. With the magnetizations of the magnetic regions being parallel or antiparallel to each other, the resulting spin injection current includes a term proportional to the square of the signal current so that the detector behaves as a square-law detector. Such square-law detectors are magnetic-semiconductor heterostructures and can operate as a frequency doubler for millimeter electromagnetic waves.

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